Aspects of the Flora, and Ecology of Savannas of the South Indian Hills

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Two biological criteria enable us to characterise the high plateaux of south India above an altitude of 1700-1900 m. : the floristic peculiarities and the different types of savannas.

These high plateaux are essentially covered with savannas, generally shrubby or bushy, fundamentally different from those of lower elevation. These are grassy formations, usually dense and low, often traversed by fire. Their physiognomy, floristic composition and dynamism are determined by the biotic factors and different types of soils and climates.

Their climate may be classified amongst the tropical humid or subhumid types, locally sub-dry ($<$ 1000 mm. rainfall, 3 to 4 months dry), with a moderately cool season (mean temperature of the coldest month between 10 and 15°C) with some days of frost per year (from December to March). These winter months are either dry or only slightly humid. At this altitude all the soils form part of the group of leached ferrallitic soils.

At least four types of altitudinal savannas developing on firm ground may be recognised. They are described.

Aspects of the Flora

At these altitudes I have encountered 356 indigenous and spontaneous species which are not found at lower altitude. Most of these are endemic because 223 *species are known only in the 'montane stage' of south India ;* 17 are also known in northern India, particularly in the Himalayas ; 52 are also reported in Ceylon whereas 36 extend to different countries of Asia. *Therefore, most of the typical species of the 'montane stage' have a limited geographic distribution because* 275 *species out of* 380 *are localised in the hills of south India and Ceylon.*

Another peculiarity is that this typical flora is herbaceous. Out of 380 species, 201 are endemic herbs, 44 are undershrubs. Out of 223 endemic species, 92 are herbaceous and 37 undershrubs or *hemixyles.* Many of these are savanna species. In this article I have limited myself to the montane flora of the Nilgiris and Palni.

(a) *Species probably endemic in the montane stage of the Nilgiris*

Taking into account the multiplicity of the dispersal mechanisms of the species (*see* Razi 1950, 1954) and the proximity of the Palni and Anaimalai, the abundance of the endemic in the montane domain of the Nilgiris is surprising even without counting varieties and subspecies. 82 species (66 Dicots and 16 Monocots) are exclusively confined to this region. All of these are cited below to enable future research workers to bring further precision.

Dicotyledons

Acanthaceae

Andrographis lawsoni Gamb.
A. lobelioides W.
A. stellulata Cl.
Leptacanthus amabilis (Cl.) Brem.
Phlebophyllum lanatum (Nees) Brem.
Nilgirianthus papillosus (T. And.) Brem.
Pleocanthus sessilis (Nees) Brem.
Mackenziea violacea (Bedd.) Brem.
Nilgirianthus wightianus (Nees) Brem.

Araliaceae

Schefflera rostrata Harms

Asclepiadaceae

Brachylepis nervosa W. & A.

Caprifoliaceae

Viburnum hebanthum W. & A.

Celastraceae

Microtropis ovalifolia W.

Geraniaceae

Biophytum polyphyllum Munro
Impatiens beddomei Hk. f.
I. debilis Turcz.
I. laticornis C. Fisch.
I. lawsoni Hk. f.
I. neo-barnesii C. Fisch.
I. nilgirica C. Fisch.
I. orchioides Bedd.
I. rufescens Benth.
I. tenella Heyne

Labiatae

Leucas rosmarinifolia Benth.
Orthosiphon rubicundus Benth. var. *hohenackeri* Hk. f.
Pogostemon nilagiricus Gamb.
P. paludosus Benth.
Teucrium wightii Hk. f.

Berberidaceae

Berberis nilghiriensis Ahrendt.

Compositae

Anaphalis neelgherryana DC.
A. notoniana DC.
Helichrysum wightii Cl.
Senecio kundaicus Fisch.
S. lawsoni Gamb.
S. lessingianus Cl.
S. polycephalus Cl.
Yungia nilgirriensis Bab.

CONVOLVULACEAE

Argyreia nellygherya Choisy.

EUPHORBIACEAE

Dalechampia velutina W.

GENTIANACEAE

Swertia trichotoma Wall.

PAPILIONACEAE

Alysicarpus beddomei Schindl.
Crotalaria barbata Grah.
C. candicans W. & A.
C. formosa Grah.
Dalbergia gardneriana Benth.

PIPERACEAE

Piper pikarhense C.DC.
P. ootacamundse C.DC.

HYPERICACEAE

Hypericum japonicum Thunb. var. *major* Fys.

RUTACEAE

Melicope indica W.

SYMPLOCACEAE

Symplocos microphylla W.

UMBELLIFERAE

Bupleurum plantaginifolium W.
Heracleum hookerianum W. & A.

LAURACEAE

Cinnamomum perrottetii Meissn.

ROSACEAE

Pygeum sisparense Gamb.
Rubus rugosus Sm. var. *thwaitesii* Focke

RUBIACEAE

Oldenlandia hirsutissima O. Kze.
O. sisaparensis Gamb.
Ophiorrhiza pykarensis Gamb.
Pavetta breviflora DC. var. *ciliolata* Gamb.
P. hohenackeri Brem.

LORANTHACEAE

Dendrophthoe neelgherrensis Van. Tieghem. var. *clarkei* Hk. f.
Loranthus recurvus Wall.
Viscum orbiculatum W.

MELASTOMACEAE

Memecylon flavescens Gamb.

MIMOSACEAE

Acacia hohenackeri Craib.

MYRTACEAE

Syzygium montanum Gamb.

Monocotyledons

AROIDEAE

Arisaema tuberculatum C. Fisch.
A. tylophorum C. Fisch.

CYPERACEAE

Ascopholis gamblei C. Fisch.
Carex pseudo-aperta Boeck

ERIOCAULACEAE

Eriocaulon pectinatum Ruhl
E. robustum Steud.

GRAMINEAE

Arundinaria wightiana Nees var. *hispida* Gamb.
Helictotrichon asperum (Munro) Bor var. *polyneuron* C. Fisch.
Eriochrysis rangacharii C. Fisch.
Garnotia geniculata Santos
Isachne deccanensis Bor
Poa gamblei Bor

ORCHIDACEAE

Cirrhopetalum acutiflorum A. Rich.
Coelogyne odoratissima Lindl. var. *angustifolia* Lindl.
Habenaria fimbriata W.
Liparis biloba W.

The Nilgiris appear as an important centre of speciation in south India, next only to Travancore and Tirunelveli.

(b) *Species probably endemic in the montane stage of the Palni*

I have counted 18 species, 15 Dicots, 3 Monocots :

Two trees : *Actinodaphne bourneae* Gamb., *Pittosporum undulatum* Vent ; seven small ligneous species: *Crotalaria conferta* Fys., *C. kodaiensis* Deb and Biswas, *Rubus fairholmianus* Gardn., *Vernonia pulneyensis* Gamb., *V. fysonii* Cald., *Anaphalis beddomei* Hk. f., *Anisochilus argenteus* Gamb. ; eight herbs : *Acrocephalus palniensis* Muk., *Anotis longiflora* Hutch., *Emilia zeylanica* Cl. var. *paludosa* Gamb., *Pimpinella pulneyensis* Gamb., *Christisonia saulierei* Dunn., *Garnotia palniensis* Santos, *Carex raphidocarpa* Nees and *Habenaria elliptica* W. ; and one climber : *Melothria angulata* Chak.

Endemism in the montane stage of the Palni (18 species) and Anaimalai (13 species) is therefore very low compared to that of the Nilgiris. This leads us to the conclusion that many of the species formed in the Nilgiris have not left this massif.

The explanation seems to be that the *anemochores* appearing on the Nilgiris have only a very slight chance of reaching the hills lying further south as the dominant winds blow from the south-west. It is also probable that there are among them neo-endemics which have not yet migrated southwards. As a matter of fact there is no ecological barrier between different localities in the montane stage of south India and Ceylon (Legris & Blasco 1969). A number of trees, mostly *zoochore*, are known from all these hills and high altitude of Ceylon ; examples are *Ilex wightiana* Wall., *I. denticulata* Wall., *Microtropis ramiflora* Wt., *Casearia coriacea* Thw., *Syzygium calophyllifolium* Walp., *Viburnum erubescens* Wall., *Vaccinium leschenaultii* Wt., *Rapanea wightiana* Mez., *Olea poly-*

gama Wt., *Symplocos obtusa* Wt., *Excoecaria crenulata* Wt., *Pittosporum tetraspermum* W. & A., *Meliosma wightii* Planch., *Michelia nilagirica* Zenk. etc. . . .

None of these extend up to the Himalayas.

(c) *Asiatic and Himalayan species known only in the montane domain* (*or stage*) *of south India.*

The classical example is that of *Rhododendron*, the geographic races of which, sub-species or species of south India and Ceylon (*R. nilagiricum* Zenk. and *R. zeylanicum* Hort. ex Loud.) differ slightly from the Himalayan type (*R. arboreum* Sm.).

The other ligneous species *Berberis tinctoria* Lesch. and *Cotoneaster buxifolia* Wall., have ecology and distribution similar to that of *Rhododendron*. For the herbaceous species, the distribution is yet wider. *Fragaria indica* Andr., *Potentilla kleiniana* W. & A. *Viola patrinii* DC., *V. serpens* Wall., *Thalictrum javanicum* Bl. are the Asian *orophytes* occurring beyond the limits of Indian territory.

Origin of species in south India

I shall only mention those species like *Eurya japonica* Thunb., *Evodia lunu-ankenda* Merr., *Ternstroemia japonica* L. encountered in different countries of Asia which have a sufficiently vast ecological amplitude to reach the montane stage in south India. As they also occur at lower altitude, they are not characteristic of montane stage.

On the other hand, some Asiatic trees and shrubs not large in number (*Glochidion fagifolium* Hk. f., *Daphniphyllum neilgherrense* Ros., *Pentapanax leschenaultii* Seem., *Rhodomyrtus tomentosa* Wt.) are typical of the montane stage.

The theories proposed till now to explain the presence of these species requiring cool climate in south India envisage large topographic or climatic changes which to this author do not appear indispensable for the explanation.

It is tempting to think that the Pleistocene glaciation, probably felt in the Himalayan region, favoured the North-South migration of a part of the subtropical flora. It has also been pointed out that ' the various stations at which a particular species is found at present, once formed part of a continuous range of distribution of the species . . . . In the regions in between the stations it has died out due to topographical changes leading to climatological variations' (Hora in Croizat 1968, p. 544).

These two hypotheses do not easily apply to the species considered here. Firstly because the continuity of the Eastern Ghats if at all it existed, dates from the Tertiary. Beyond a few million years many species of Angiosperms would have evolved or disappeared. In this hypothesis (Zeuner 1958, p. 392; Kremp 1969) the theory of physical continuity cannot be retained for the species presently common to south India and Himalayas.

As for the recent large thermic fluctuations (less than 100,000 years) if they took place, why should the southward migration of *Rhododendron* and *Berberis* have been permitted and not of Fagaceæ and Conifers? This remark is as much valid for *Quercus incana* Roxb., and *Pinus roxburghii* Sargent, for example, which occur side by side in the same zone in Western Himalayas. One may add other important instances, particularly the genus *Pieris* (Ericaceae) totally absent in the south. If the Himalayan Fagaceae, Betulaceae and Conifers do not occur spontaneously on the south Indian hills it is because they never came there. Their recent introduction by man shows that the habitat is well suited to these species.

In the regions where the physical continuity of the mountains really existed, the Conifers, Fagaceae, Betulaceae, Ericaceae etc . . . are very abundant at equal latitude. This is the case of the southern extremity of the Annamitic Range in South Viet Nam.

Finally, concerning the land connections between India and Ceylon it is the belief to-day that the last separation is recent (about 10,000 years) but the real disappearance of the Gulf of Mannar would date from the commencement of the Pleistocene and there is nothing to prove that there was in its place a high mountain. Anyway neither the paleoclimatology nor the present ecological conditions explain the presence of the Ceylonese species in the Nilgiris having jumped over all the other hills of south India including the Palnis; such is the case of *Oldenlandia verticillaris* O. Kze., *Vernonia pectiniformis* DC., *Crepis fuscipappa* Benth., *Olea polygama* Wt., *Tylophora iphisia* Dcne., *Ceropegia decaisneana* Wt., *Scutellaria wightiana* Benth., *Sarcococca brevifolia* Stapf etc. (I shall not raise the question of *polytopism* here. In spite of appearance, the Himalayan *milieu* beyond 27°N is very different from that of the Ceylon mountains near the equator so that the genesis of identical species in the two cases should be an uncommon phenomenon).

The argument that cites the mammals presently common to Nilgiris southern Hills and Himalayas does not seem conclusive. *Martes gwatkinsi* Horsfield, the Nilgiri marten, is a species capable of moving down to 900 m. and even lower elevations. The same is the case with *Hemitragus hylocrius* Ogilby, the Nilgiri Tahr.

Under such conditions it seems logical to explain the presence of species common to Ceylon, south India and Himalayas by their actual means of dispersal rather than by palaeogeographic hypotheses. A more likely explanation may be given by examining the means of dispersal of south Indian species having definite Himalayan affinities.

Seeds of *Rhododendron arboreum* Sm. are remarkably adapted to vast displacements. Extremely numerous, minute, flattened, oblong, provided with a tuft of hairs at each extremity, they are susceptible to long transport thanks to wind and birds.

In *Berberis tinctoria* Lesch. much appreciated by the hill thrushes (*Zoothera*) and in *Cotoneaster buxifolia* Wall. the dispersal of the seeds is usually of *endozoic* type as in most of the species of *Fragaria*, *Potentilla*, *Viola*, *Thalictrum*, *Eurya*, *Osyris*, *Passiflora*, *Gaultheria* etc.[1] In *Crepis* and *Dicrocephala* the means is essentially *epizoic*.

All these species and almost all the plant species common to south India and Himalayas behave as vigorous pioneers, particularly apt to colonise the deforested lands of the montane domain. This characteristic behaviour of the species recently naturalised in a habitat quite different from that of their origin weakens the hypothesis of vestigeal species.

(d) *Conclusion*

The typical species of the montane stage of south India are essentially herbaceous endemics or are known in Ceylon also. A less important group comprises species extending up to the Himalayas. As a matter of fact these are the herbaceous *orophytes* known in different countries of S.E. Asia. In spite of vast discontinuities in areas, this group probably does not represent a vestige of an ancient epoch having completed their migration step by step. An examination of the possible mechanisms of dispersal of these species shows the floristic exchanges between the Himalayas and the Nilgiris as recent or sub-contemporary. Unfortunately, we yet know very little about the seasonal movements of some 350 species of migratory birds actually known in India. The migration study project undertaken in March 1970 at Srinagar by the Bombay Natural History Society may help to bring to light new explanations towards the modern flora of the mountains of Peninsular India.

Main Savanna types and their ecology

These hill plateaux may be characterised by their vegetation types, both ligneous and herbaceous. I shall deal with principal herbaceous types which by far occupy the largest area.

(1) **Chrysopogon zeylanicus—Arundinella** spp. type

This formation is characterised and easily recognised by the dominance of *Chrysopogon zeylanicus* Thw. It is a voluminous Gramineæ, with narrow, rigid leaves left ungrazed by the cattle. Its development in south India and Ceylon is linked to the working of the soil by man. Presently, these savannas essentially cover all the areas of old plantations of *Eucalyptus*, *Acacia* or other vegetable crops.

[1] Ridley (1930) and Olson (1968) give data on this type of dispersal.

In the Nilgiris, they are well represented on the Wenlock Downs. Vast stretches are encountered in the Mukurti region. *Arundinella fuscata* Nees of low size is often abundant.

In the Palnis, the valleys around Kodaikanal (Gundar, Koniar, Kumbar etc.) include good examples of this savanna. Here *Arundinella vaginata* Bor is co-dominant with *Chrysopogon zeylanicus* Thw.

In Ceylon, particularly on the Horton Plains, the type grows under a climate more humid than that of south India notably from December to April. Principal grasses are *C. zeylanicus* Thw. and *A. villosa* Arn.

Grasses generally common to all these savannas but rarely dominant are *Eulalia phaeothrix* (Hack.) O. Ktze., *Themeda triandra* Forsk., *Andropogon lividus* Thw., *Ischaemum aristatum* L. etc. In depressions, with increasing hydromorphy of the soils, *Helictotrichon asperum* (Munro) Bor becomes very common, especially in the Palnis ; in Ceylon it is *Garnotia mutica* Fanowsky.

Marked floristic differences are noted according to the regions. For the Nilgiris I have enumerated 60 endemic Dicots and 13 endemic Monocots above 1800 m. The floristic wealth of this hill reflects also in the flora of the savanna. *Pleocanthus sessilis* (Nees) Brem., *Leucas rosmarinifolia* Benth., *Heracleum hookerianum* W. & A., *Senecio polycephalus* Cl., *Anaphalis neelgherryana* DC. etc. impart a floristic character unknown in the Palnis. Besides, many of the savanna species of the Nilgiris tolerate hydromorphic soils. Examples are *Anemone rivularis* Ham., *Impatiens chinensis* L., *Serpicula hirsuta* W. & A., *Dipsacus leschenaultii* Coult. frequent in the savannas of Avalanche in the Nilgiris but practically unknown in the same savanna type of the Palnis.

The abundance of hygrophytic species is yet more marked in Ceylon where one notes numerous *Carex*, *Fimbristylis*, *Ranunculus sagittifolius* Hk., *Osbeckia cupularis* Don, *Oldenlandia verticillaris* O. Kze. etc.

Bioclimate : The temperature conditions vary little from one place to the other in all savannas of high plateaux. Therefore it is not the temperature factor that plays the role determining the main formations.

Low temperatures, varying between –1 to –9°C, were registered under savannas for some days during the period December to March at sunrise. The diurnal thermic amplitude between 6 a.m. and 2 p.m. is very high in winter, often above 35°C.

The high annual rainfall of Ceylon (> 2000 mm.) and Nilgiris (> 1800 mm.) permits the development of hygrophytes even on the slopes. On the other hand, in the Palnis where rainfall in these savannas is of the order of 1400 mm., hygrophytes are rare or absent.

Soils : Table 1 gives the results of chemical analysis of a soil collected under *Chrysopogon zeylanicus* Thw. from the Palnis.

TABLE 1

Depth cm.	Horizons	Pebbles & Gravel %	Mechanical analysis				pH H_2O 1/2, 5	pH KCl	Exchangeable cations m. e./100 gm.				Total exchangeable cations m. e./100 gm.	Exchange capacity m. e./100 gm.	Si O_2/Al_2O_3	Organic matter	
			Clay 0 to 2μ	Fine silt 2 to 20μ	Coarse silt 20 to 50μ	Sand 0, 05 to 2 mm.			Ca	Mg	K	Na				C ‰	C/N
—20	A1	7·3	19·8	7·9	2·6	58·2	5·5	4·6	0·7	0·4	0·3	0·1	1·5	5·3	1	49·9	19
—20 to 60	AB	34·6	14·5	7·5	2·5	71	5·6	4·9	0·2	0	0·1	0·2	0·5	2·4	1	18·6	13
<—60	B	9·8	14·6	13·5	6	66·1	5·71	5·8	0·2	0	0·1	0·1	0·4	—	1	2·3	2

A1 = surface organic horizon, dark brown (7, 5 YR 1/1), fine, gritty structure. Very porous. Contains numerous roots without preferential orientation.

AB = Gravelly horizon, containing organic material but more or less concretionary rocky material represents 35% of air-dry soil.

B = Sandy clayey horizon, light orange (7, 5 YR 5/1) constantly humid. There are practically no living roots at this level.

(2) **Eulalia phaeothrix—Arundinella fuscata** low savanna type

Dense and continuous grassy formation without trees or shrubs particularly well represented in the Pulavachiar valley in the Palnis. *Eulalia phaeothrix* (Hack.) O. Ktze. and *Arundinella fuscata* Nees are the dominating species of this type which differs from the preceding type essentially by the absence of working of the soil by man (which explains why *Chrysopogon zeylanicus* Thw. has not been able to penetrate) and by higher number of foggy days (probably 180 per year at least).

Moreover, soil profiles usually show under A1 horizon a A12 layer of bulky structure in a wet state.

The absence of plantations till recent years is an indication that fire runs through these savannas almost every year. Shrubs have disappeared except *Rhododendron nilagiricum* Zenk. and *Gaultheria fragrantissima* Wall. in the hollows. *Hypericum mysorense* Heyne, *Vaccinium leschenaultii* W. so common in the *Chrysopogon* savannas are totally absent.

The atmospheric humidity and the presence of A12 soil horizon with high water retentive capacity may explain the presence of species usually seen in humid depressions: *Ranunculus reniformis* Wall., *Impatiens tomentosa* Heyne., *Heracleum rigens* Wall. Gard., *Carex lindleyana* Nees etc....

These savannas are among the most stable types of the plateaux. No distinct trace of dynamism has been noted in the sense that no ligneous element has been observed.

(3) **Heteropogon contortus—Arundinella mesophylla** type

These are the formations on highly eroded soils well developed under a sub-dry climate of the interior depressions of the Palnis. Good examples are those of Mannavanur.

Characterised by a high density of the tufts of *Heteropogon contortus* (L.) Beauv. and *Arundinella mesophylla* Nees closely mixed together, these savannas are rich in species having a large range of distribution: *Coleus forskohlii* (Poir.) Briq., *Polygonum chinense* L., *Micromeria biflora* Benth., *Sopubia trifida* Ham., *Striga lutea* Lour., *Polycarpaea spicata* W. & A., *Borreria ocymoides* DC. etc.

In spite of its awns, *H. contortus* (L.) Beauv. is easily browsed by cattle. If the grazing rotation is very short and if the cutting is followed by sheep grazing then there is considerable deterioration of the pasture marked by a rapid development of wooly Compositæ like *Anaphalis lawii* Gamb. and *Laggera alata* Sch. Bip. which are not grazed by cattle. It is necessary to maintain a strict check on the rational use of the pastures of this region where cattle-breeding is gaining importance.

The bioclimates of these regions may be characterised by annual rainfall of 1000 mm. with 2 to 3 months dry (December to February or January to March.)

The soils unlike those previously described have a thin surface horizon, littered with fragments of altered rock. The following Table 2 gives its essential characteristics.

(4) High rainfall savannas

These are encountered only in the southern and western parts of the Nilgiris which are extremely windy and rainy during the S.W. monsoon. The Western Catchment for example at 2400 m. altitude is one of the most rainy regions of S.E. Asia and probably also of the tropical mountains. Mean annual rainfall usually exceeds 5000 mm.; figures of 2000 to 4000 mm. in one single month—July or August—are not rare. In the Upper Bhavani and Arikayampuzha, fall of 6056 mm. was recorded between June 1st and July 31st 1959 and 5200 mm. during the same period in 1961. Fundamental trait of this climate is the extreme violence of winds and summer rains, the erosive power of which are considerable.

Soils of the regions are often reduced to lithosols in which the finer fraction is that which remains imprisoned within the network of the roots of grasses. These soils become very dry after the cessation of rains.

The vegetation is characterised by a herbaceous cover, more or less discontinuous because of rocky outcrops. Three woody species are met with in a stunted form: *Rhododendron nilagiricum* Zenk., *Ligustrum perrottetii* A.DC. and *Syzygium calophyllifolium* Walp. A number of small shrubs or *chamaephytes* are encountered which are absent in the Palnis: *Strobilanthes wightianus* Nees, *S. lawsonii* Gamb., *Teucrium wightii* Hk.f., *Leucas suffruticosa* Benth., *Anaphalis neelgherryana* DC., *A. wightiana* DC., *Andrographis lawsoni* Gamb. etc....

The grasses well adapted to maintain themselves in these regions are *Themeda triandra* Forsk. and *Isachne kunthiana* Miq. During the rainy season a number of *Impatiens* spp. may be collected: *I. tomentosa* Heyne, *I. crenata* Bedd., *I. acaulis* Arn., *I. clavicornu* Turcz., *I. pusilla* Heyne, *I. scapiflora* Heyne, etc....

The ecology of this type of savanna is not conducive to the growth of trees. Low winter temperatures, violence of winds and rains resulting in soils poor in fine materials render the working and afforestation of this part of the Nilgiris a difficult task.

Under similar ecological conditions I have located at Sispara in the Nilgiris, another savanna type where *Andropogon lividus* Thw. is very abundant. However this type occupies a small area.

Such are the general characteristics of the main savanna types of these hills. Every study concerning the dynamism of the indigenous

TABLE 2

Depth cm	Horizons	Pebbles & Gravel %	Mechanical analysis				pH H_2O 1/2, 5	pH KCl	Exchangeable cations m. e./100 gm.				Total exchangeable cations m. e./100 gm.	Exchange capacity m. e./100 gm.	SiO_2/Al_2O_3	Organic matter	
			Clay o to 2μ	Fine silt 2 to 20μ	Coarse silt 20 to 50μ	Sand 0, 05 to 2 mm.			Ca	Mg	K	Na				C ‰	C/N
—8	A1	27·3	18·1	6·6	1·3	64.4	5·7	4·8	4·1	2·3	0·6	0·3	7.3	8	1·9	32·1	17
—8 —35	AB	62·6	22·2	9·2	0·5	59·1	5·5	4·5	2·1	1·3	0·3	0·2	3·9	7·7	1·9	28·7	15
—35 —60	(B)	14·1	15·6	8	1·3	71·12	5·4	4·5	0.8	0·8	0.3	0.2	2.1	4·1	2	12·4	14
<—60	C′	0	26·3	23·2	8·09	41·3	5·6	4·5	0·3	1·1	0·1	0·3	1·8	·4	1·3	1·9	

trees and shrubs, distribution of flora, land-use etc. must take into account the sub-divisions of the savannas of the high plateaux into four groups, described above.

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